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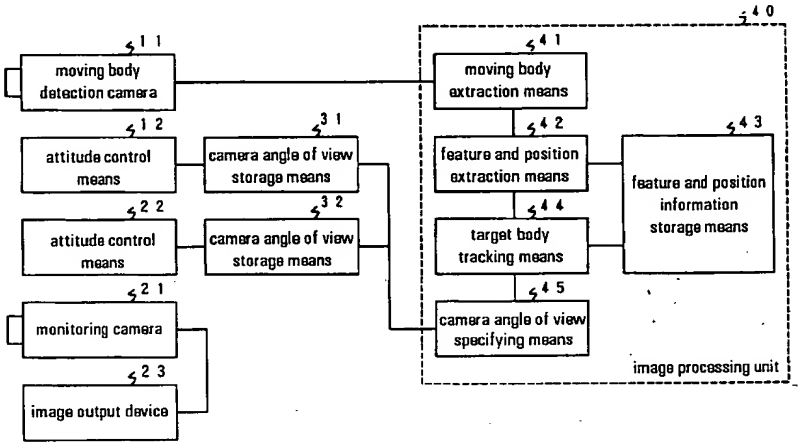
Title Monitoring Camera System

Abstract

OBJECT: To provide a monitoring camera system in which the image from the monitoring camera for automatically tracking a moving body is subject to little shake, and in which there is little load on the universal head.



CONSTITUTION: Comprises a moving body detection camera 11 capable of capturing images of a moving body over a wide image capture area; a monitoring camera 21 for acquiring an enlarged image of a moving body; a first and a second attitude control means 12 and 22 for controlling the attitudes of moving body detection camera 11 and monitoring camera 21 respectively; a first and a second camera angle of view storage means 31 and 32 serving to give first and second attitude control means 12 and 22 instructions by calling [1]* a plurality of angle of view information items that have been stored in advance; and image processing unit 40 for extracting features of a moving body from the image from moving body detection camera 11, and for selecting appropriate information on the basis of the plurality of angle of view information items that have been stored in the first and the second camera angle of view storage means 31 and 32.

Claims

1. A monitoring camera system characterised in that it comprises:

a moving body detection camera capable of capturing images of a moving body over a wide image capture area;

a monitoring camera for acquiring an enlarged image of a moving body;

a first and a second attitude control means for controlling the attitudes of said moving body detection camera and said monitoring camera respectively;

a first and a second camera angle of view storage means for giving said first and second attitude control means instructions by calling a plurality of angle of view information items that have been stored in advance;

and an image processing unit for extracting features of a moving body from the image from said moving body detection camera, and for selecting appropriate information on the basis of the plurality of angle of view information items that have been stored in said first and second camera angle of view storage means.

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* Numbers in square brackets refer to Translator's Notes appended to the translation.

2. The monitoring camera system according to Claim 1, which captures a moving body within the image capture area of said monitoring camera by means of discreet control of said second attitude control means, this control being effected by switching camera angle of view information comprising horizontal angle of view information, vertical angle of view information and increase/decrease angle of view information, these items of information having been established in advance.

3. The monitoring camera system according to Claim 1, which, provided that the moving body does not go outside an area defined as being a set distance from the centre of the screen of said monitoring camera, does not cause said monitoring camera to swivel.

4. The monitoring camera system according to Claim 1, which captures a moving body in the image capture area of said monitoring camera while decreasing inappropriate switching of angle of view information of said monitoring camera, by setting adjacent camera angle of view information in such manner that it overlaps with the image capture area of the camera.

5. The monitoring camera system according to Claim 1, which captures a moving body in the image capture area of said moving body detection camera, by causing said moving body detection camera to swivel in the direction of movement of the moving body before the moving body leaves the image capture area of said moving body detection camera.

6. The monitoring camera system according to Claim 1, wherein said image processing unit comprises:

a moving body extraction means for extracting a moving body from the image from said moving body detection camera;

a feature and position extraction means for extracting the features and positions of an individual moving body on the basis of the extraction result of said moving body extraction means;

a feature and position information storage means for storing past feature and position information;

a target body tracking means for deciding, from the features of the moving body, whether or not it is a target body, and for correlating it with a past target body that has been stored in said feature and position information storage means; and

a camera angle of view specifying means for indicating to said camera angle of view storage means a camera angle of view corresponding to the tracking result.

Detailed Description of the Invention

Technical field of the invention

(1) The present invention relates to monitoring camera systems for tracking, capturing images of, and monitoring a moving body.*

* Numbers in round brackets at the beginning of paragraphs correspond to the paragraph numbering in the Japanese patent document.

Prior art

(2) A conventional monitoring camera system generally has a moving body detection camera and a decision camera [2], detects a moving body by means of the moving body detection camera, and causes the universal head of the decision camera to swivel in such manner that the moving body in question is located in the centre of the decision camera screen. An example of such a monitoring camera system is set forth in Japanese Unexamined Patent Publication No. 07-037100.

(3) The monitoring camera system set forth in this publication comprises a moving body detection camera, a decision camera, a decision processing unit, and an information processing unit. Using these two cameras, the system reliably detects — over a wide image capture area with no blind spots — a moving body and captures images of this moving body in a condition required for a decision. The moving body detection camera monitors a 360° area by means of an approximately conical reflecting mirror arranged above it, and outputs information relating to the position and area of the moving body. The information processing unit transforms coordinates on the reflecting mirror to coordinates on the monitoring area plane. The decision processing unit decides on the swivel angle and the angle of inclination or declination on the basis of the position information, and also decides on magnification on the basis of the area information, in such manner that the moving body is located in the centre of the screen of the decision camera. The decision camera captures the moving body by swivelling on the basis of the output of the decision processing unit.

(4) Another example of a monitoring camera system is set forth in Japanese Unexamined Patent Publication No. 59-221191. The monitoring camera system described in this publication comprises a television camera, a video memory, a control circuit, a common memory, an output image memory, an output circuit, an output device, a change extraction circuit, an outline extraction circuit, a centre extraction circuit and a tracking circuit, and causes the television camera to move so as to match the movement of a moving body that has entered the angle of view of the television camera. The video memory successively updates and stores images that have been input by the television camera. The control circuit controls each of the other circuits and also controls the flow of information. The common memory is accessed by each of the other circuits. The output image memory stores image information to be output to the output device. The output circuit converts information in the output image memory to a video signal and displays images on the output device. The change extraction circuit finds the difference between the common memory and the output image memory, and extracts the change component between the current and previous input images. The outline extraction circuit extracts the outline of a moving body that is present when there has been a change. The centre extraction circuit extracts the centre or centre of gravity of the moving body on the basis of the outline information obtained by the outline extraction circuit. The tracking circuit causes the centre of the lens of the video camera to move to the centre of the moving body in response to a change in that centre.

Problems which the invention will solve

(5) The following sorts of problems are encountered in conventional monitoring camera systems including the examples described above.

(6) The first problem is that when a moving body stops, it takes time for shaking of the camera image to settle down. This is because the universal head is controlled in such manner that the centre of gravity of the moving body is always kept positioned in the centre of the screen.

(7) The second problem is that the camera image shakes while the moving body is being tracked. This is because the universal head is controlled in such manner that the extracted centre of gravity of the moving body is always kept positioned in the centre of the screen despite the fact that because the extracted centre of gravity of the moving body is not always absolutely in agreement with the centre of gravity of the actual moving body, the locus of the extracted centre of gravity does not describe a smooth curve.

(8) The third problem is that the computation required for controlling the universal head is complicated. This is because in order to control the universal head so that the centre of gravity of the moving body is always kept positioned in the centre of the screen, not only the movement of the moving body but also the characteristics of the universal head have to be taken into consideration.

(9) The fourth problem is that the universal head has a short lifetime. The reason for this is that the universal head is subjected to loading in the course of performing the precise control required to ensure that the centre of gravity of the moving body is always kept positioned in the centre of the screen.

(10) A task for the present invention is to provide a monitoring camera system capable of tracking a moving body with little image shake.

(11) A further task for the present invention is to provide a monitoring camera system with simplified processing.

(12) Yet another task for the present invention is to provide a monitoring camera system in which control commands are only infrequently given to the universal head, and in which there is little component wear.

Means for solving problems

(13) The present invention provides a monitoring camera system characterised in that it comprises: a moving body detection camera capable of capturing images of a moving body over a wide image capture area; a monitoring camera for acquiring an enlarged image of a moving body; a first and a second attitude control means for controlling the attitudes of the moving body detection camera and the monitoring camera respectively; a first and a second camera angle of view storage means for giving the first and second attitude control means instructions by calling a plurality of angle of view information items that have been stored in advance; and an image processing unit for extracting features of a moving body from the image from the moving body detection camera, and for selecting appropriate information on the basis of the plurality of angle of view information items that have been stored in the first and second camera angle of view storage means.

(14) The present invention also provides a monitoring camera system which captures a moving body within the image capture area of the monitoring camera by means of discreet control of the second attitude control means, this control being effected by switching camera angle of view information comprising horizontal angle of view

information, vertical angle of view information and increase/decrease angle of view information, these items of information having been established in advance.

(15) The present invention further provides a monitoring camera system which, provided that the moving body does not go outside an area defined as being a set distance from the centre of the screen of the monitoring camera, does not cause the monitoring camera to swivel.

(16) The present invention also provides a monitoring camera system which captures a moving body in the image capture area of the monitoring camera, while decreasing inappropriate switching of angle of view information of the monitoring camera, by setting adjacent camera angle of view information in such manner that it overlaps with the image capture area of the camera.

(17) The present invention still further provides a monitoring camera system which captures a moving body in the image capture area of the moving body detection camera, by causing this moving body detection camera to swivel in the direction of movement of the moving body before the moving body leaves the image capture area of the moving body detection camera.

(18) The present invention also provides a monitoring camera system wherein the image processing unit comprises: a moving body extraction means for extracting a moving body from the image from the moving body detection camera; a feature and position extraction means for extracting the features and positions of an individual moving body on the basis of the extraction result of the moving body extraction means; a feature and position information storage means for storing past feature and position information; a target body tracking means for deciding, from the features of the moving body, whether or not it is a target body, and for correlating it with a past target body that has been stored in the feature and position information storage means; and a camera angle of view specifying means for indicating to the camera angle of view storage means a camera angle of view corresponding to the tracking result.

Working of the invention

(19) When moving bodies enter an image capture area of the moving body detection camera, the moving body extraction means extracts the moving bodies, the feature and position extraction means obtains the features and positions of the moving bodies, and the target body tracking means, while referring to information in the feature and position information storage means, decides which of the moving bodies to track as a target body, and obtains its position. On the basis of the position of the target body being tracked, the camera angle of view specifying means selects the most suitable of the items of information that have been stored in the camera angle of view storage means. The camera angle of view storage means controls the attitude control means on the basis of the selected camera angle of view information. Consequently, the present invention is capable of capturing a moving body with the monitoring camera by means of the minimum amount of attitude control.

Mode of embodying the invention

(20) A mode of embodying the monitoring camera system of the present invention will now be described with reference to the drawings.

(21) FIG. 1 is a block diagram showing the constitution of this mode of embodying the monitoring camera system of the present invention. Referring to FIG. 1, it will be seen that this monitoring camera system comprises: moving body detection camera 11; attitude control means 12 serving as the first attitude control means and being a universal head or the like for determining the attitude of moving body detection camera 11; monitoring camera 21; attitude control means 22 serving as the second attitude control means and being a universal head or the like for determining the attitude of monitoring camera 21; image output device 23 such as a display for displaying the image from monitoring camera 21; camera angle of view storage means 31 serving as the first camera angle of view storage means and being a preset controller or the like for controlling attitude control means 12; camera angle of view storage means 32 serving as the second camera angle of view storage means and being a preset controller or the like for controlling attitude control means 22; and image processing unit 40.

(22) Image processing unit 40 comprises moving body extraction means 41, feature and position extraction means 42, feature and position information storage means 43, target body tracking means 44 and camera angle of view specifying means 45.

(23) Camera angle of view storage means 31 and 32 store, in advance, a plurality of angle of view information items, namely, horizontal angle of view (pan), vertical angle of view (tilt) and increase/decrease angle of view (zoom), in such manner that no part of the monitoring area is left uncovered. [3]

(24) Camera angle of view specifying means 45 has a table in which the angle of view information stored in camera angle of view storage means 31 and 32 is linked to positions within the monitoring area.

(25) When a moving body enters the image capture area of moving body detection camera 11, moving body extraction means 41 of image processing unit 40 extracts the region within the screen corresponding to the moving body. Feature and position extraction means 42 obtains the features and position for each moving body region. Target body tracking means 44 compares the information relating to each moving body [4] with past moving body information that has been stored in feature and position information storage means 43, uses the closest match as the current target body, and updates the information in feature and position information storage means 43. Camera angle of view specifying means 45 selects camera angles of view such that the position of the target body obtained by target body tracking means 44 is located within the image capture areas and, if and only if these differ from the current camera angles of view, outputs, to camera angle of view storage means 31 and 32, the table number or numbers corresponding to the selected camera angle or angles of view. [5] Camera angle of view storage means 31 and 32 call the camera angle of view information from the input table number or numbers and on this basis control attitude control means 12 and 22.

(26) FIG. 2 and FIG. 3 are flowcharts serving to clarify the operation of this system. FIG. 4, FIG. 5, FIG. 6, FIG. 7, FIG. 8, FIG. 9 and FIG. 10 are drawings also serving to clarify the operation of this system, and respectively give examples of: an input image, an extracted moving body, image processing blocks and the monitoring camera angle of view (for an example where the image capture area of the moving

body detection camera has been divided into 5×5 blocks) [6], monitoring camera swivel, outermost image processing blocks, moving body detection camera swivel directions, and the overlap and swivel applied to the angle of view of the moving body detection camera.

(27) The operation of this system will now be described with reference to FIGS. 1 to 10.

(28) At step S1, if there is an input image (of the sort shown in FIG. 4) from moving body detection camera 11 of FIG. 1, moving body extraction means 41 extracts and binarizes the moving body (see FIG. 5). At step S2, it is decided whether or not there is a moving body. If there is no moving body, processing returns to step S1.

(29) At step S3, unique numbers are assigned to regions on the extracted image (such as that depicted in FIG. 5). This processing step is termed "labelling".

(30) At step S4, feature and position extraction means 42 firstly obtains, from the result of step S3, the feature vectors for all the regions, decides whether or not there is a body to be tracked (for example a person), and deletes data relating to other bodies (e.g., the swaying of trees). Next, it obtains representative coordinates (centre, lower edge, upper edge, etc.) of the remaining data.

(31) At steps S5 to S7, target body tracking means 44 searches for data where there is agreement between (i) all the current feature vector data and (ii) the latest data in the sequence of past feature vector data of feature and position storage means 43, and determines the position of the target body to be tracked. This processing is performed by going back to past data until such matching data are found.

(32) At step S8, when matching data are found, the oldest data in feature and position storage means 43 are deleted and the storage means is updated with the matching data. The screen [7] of moving body detection camera 11 is split into a number of blocks in correspondence with the angle of view information items that have been set in camera angle of view storage means 31, and camera angle of view storage means 32 has preset angles of view such that monitoring camera 21 captures an enlarged image of each of these blocks (see FIG. 6). In camera angle of view storage means 31, angles of view that have been shifted in eight adjacent directions (see FIG. 9) are preset (see FIG. 10 for an example) in such manner that they overlap with the angle of view information items stored in camera angle of view storage means 32.

(33) At step S9, camera angle of view specifying means 45 determines a new camera angle of view table number from the current angle of view of monitoring camera 21 and from the position of the tracked target body on the image blocks (see FIG. 7). If the tracked target body is positioned on an outermost block (see FIG. 8), the new camera angle of view table number is determined in accordance with one of the swivel directions shown in FIG. 9, these being the swivel directions that can be applied to moving body detection camera 11.

(34) At steps S11a and S11b, if and only if the respective new camera angle of view table numbers are different from the camera angle of view table numbers in the immediately preceding processing cycle, these table numbers are specified for camera angle of view storage means 31 and 32. On the basis of this instruction by camera

angle of view specifying means 45, camera angle of view storage means 31 and 32 send, to attitude control means 12 and 22 [8], the attitude information (pan, tilt and zoom information) that is managed by the table numbers.

(35) At steps S12a and S12b, attitude control means 12 and 22 change the attitude by means of the attitude information that has been sent from camera angle of view storage means 31 and 32, and capture the tracked target body in the image capture field (see FIG. 7 and FIG. 9). The image is displayed on image output device 23.

Working example

(36) Next, a working example of a monitoring camera system according to the present invention will be described.

(37) FIG. 11 shows the constitution of a working example of the monitoring camera system of the present invention. Referring to FIG. 11, it will be seen that this system comprises: moving body detection camera 111, its universal head 112, monitoring camera 121, its universal head 122, image splitter 123, display 124 for displaying the image from monitoring camera 121, VTR device 125 for recording images from the monitoring camera, preset controller 131 for controlling universal head 112, preset controller 132 for controlling universal head 122, and image processing unit 140 for processing the video signal from moving body detection camera 111. Note that depending on the functions of the universal heads, it may be feasible to incorporate the functions of preset controllers 131 and 132 in image processing unit 140.

(38) In this system, if a moving body enters the image capture area of moving body detection camera 111, image processing unit 140 controls universal heads 112 and 122 by selecting camera angle of view information stored in preset controllers 131 and 132 and sending commands to these preset controllers 131 and 132, whereby monitoring camera 121 captures the intruding body and displays its image on display 124. At this juncture, images of the intruder can also be recorded by sending a signal from image processing unit 140 to VTR device 125.

Effect of the invention

(39) The monitoring camera system of the present invention has the following effects.

(40) Firstly, when a moving body is in the image capture area of the monitoring camera, camera image shake — when tracking the moving body and when the moving body stops — is avoided by not controlling the universal head. The reason for this is that because the universal head is controlled only to the minimum required extent, it does not react to slight movements of the moving body.

(41) Secondly, by controlling the universal heads on the basis of calling camera angle of view information that has been stored in advance, the processing involved in universal head control is simplified and the loads on the universal heads are reduced. The reason for this is that because feedback control that takes the characteristics of the universal heads into account is not performed, processing is simpler and the universal heads are controlled less frequently.

Brief Description of the Drawings

FIG. 1 is a block diagram showing the constitution of a mode of embodying the monitoring camera system of the present invention.

FIG. 2 is a flowchart serving to clarify the operation of the monitoring camera system shown in FIG. 1.

FIG. 3 is a flowchart serving to clarify the operation of the monitoring camera system shown in FIG. 1.

FIG. 4 serves to clarify the operation of the monitoring camera system shown in FIG. 1 and is an example of an input image.

FIG. 5 serves to clarify the operation of the monitoring camera system shown in FIG. 1 and is an example of an extracted moving body.

FIG. 6 serves to clarify the operation of the monitoring camera system shown in FIG. 1 and is an example of image processing blocks and the monitoring camera angle of view (for an example where the image capture area of the moving body detection camera has been divided into 5×5 blocks).

FIG. 7 serves to clarify the operation of the monitoring camera system shown in FIG. 1 and is an example of monitoring camera swivel.

FIG. 8 serves to clarify the operation of the monitoring camera system shown in FIG. 1 and is an example of outermost image processing blocks.

FIG. 9 serves to clarify the operation of the monitoring camera system shown in FIG. 1 and is an example of moving body detection camera swivel directions.

FIG. 10 serves to clarify the operation of the monitoring camera system shown in FIG. 1 and is an example of the overlap and swivel applied to the angle of view of the moving body detection camera.

FIG. 11 is a flowchart showing the constitution of a monitoring camera system according to a working example of the present invention.

Key to referencing numerals

11, 111.....mobile body detection cameras
12, 112.....attitude control means
21, 121.....monitoring cameras
23.....image output device
31, 32 .....camera angle of view storage means
40, 140.....image processing units
41.....moving body extraction means
42.....feature vector extraction means [9]
43.....feature and position information storage means
44.....target body tracking means
45.....camera angle of view specifying means
112, 122.....universal heads
123.....image splitter
124.....display
125.....VTR device
131, 132.....preset controllers

FIG. 1

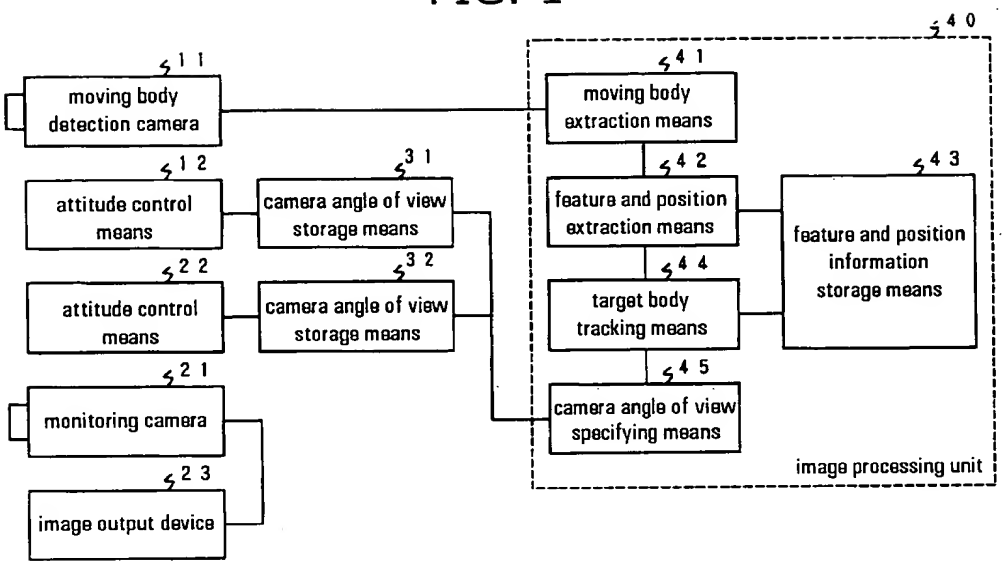

40
11
moving body detection camera
41
moving body extraction means
12
attitude control means
31
camera angle of view storage means
42
feature and position extraction means
43
feature and position information storage means
22
attitude control means
32
camera angle of view storage means
44
target body tracking means
21
monitoring camera
45
camera angle of view specifying means
23
image output device
image processing unit

FIG. 2

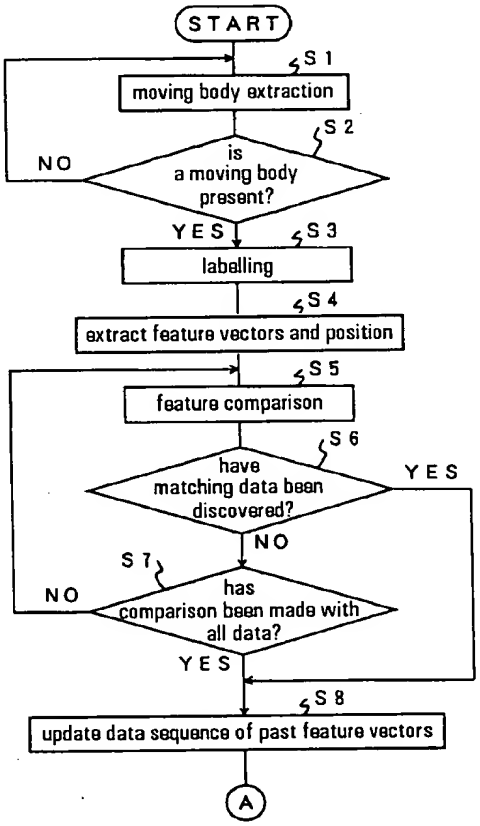

START
S1
moving body extraction
S2
is a moving body present?
NO
YES
S3
labelling
S4
extract feature vectors and position
S5
feature comparison
S6
have matching data been discovered?
YES
NO
S7
has comparison been made with all data?
NO
YES
S8
update data sequence of past feature vectors
A

FIG. 3

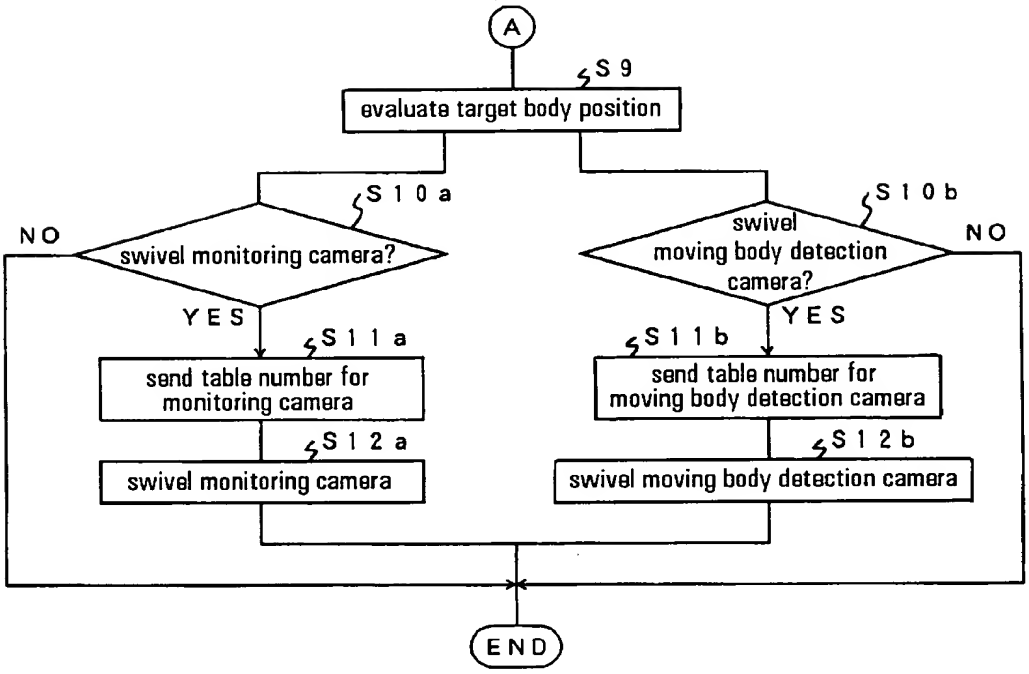


FIG. 4

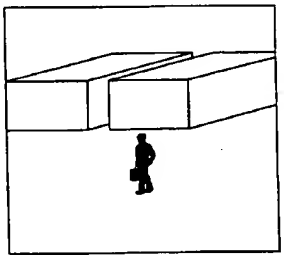


FIG. 5

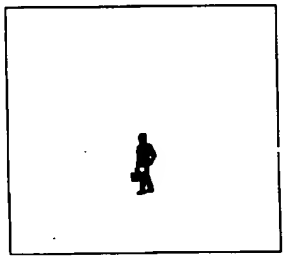


FIG. 6

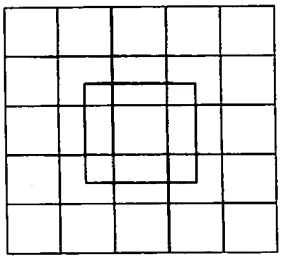


FIG. 7

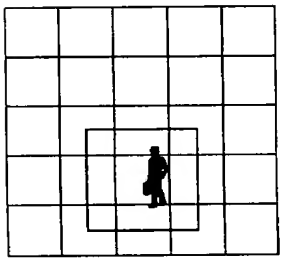


FIG. 8

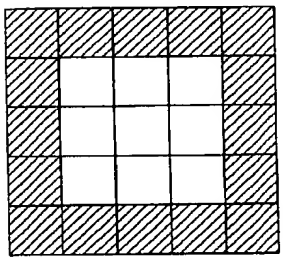


FIG. 9

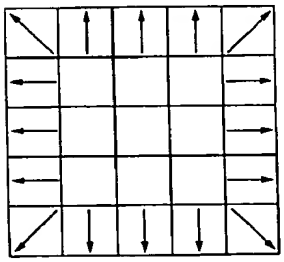


FIG. 10

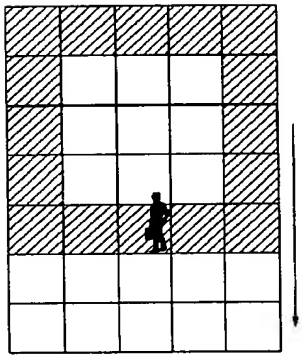
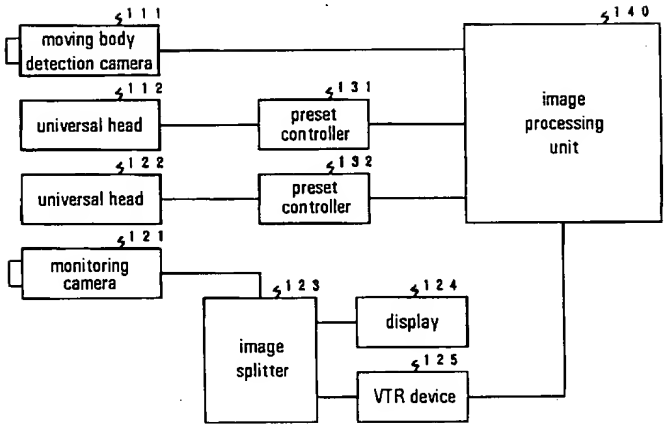


FIG. 11


111
moving body detection camera
112
universal head
122
universal head
121
monitoring camera
131
preset controller
132
preset controller
140
image processing unit
123
image splitter
124
display
125
VTR device

TRANSLATOR'S NOTES

General Note: The Japanese specification of which the above is the translation is noticeably lacking in clarity at several key points, mainly concerning (i) the interrelation between the tracking mechanisms of the two cameras and (ii) the question of the number (singular/plural) of various components/operations. My translation of some of the resulting ambiguous Japanese is therefore based, at several points, on my understanding of the substance of the invention.

1. "Calling" here is evidently used in a computer program sense. However, I wonder if "retrieving" would not have been more appropriate.

2. Sic. The writer perhaps uses the term "decision camera" to indicate that it is this camera which provides images that allow a decision to be made regarding the identity of a moving body.

3. The Japanese which I have translated as "in such manner that no part of the monitoring area is left uncovered" is literally, "so that no gaps will form within the monitoring area".

4. Japanese does not generally distinguish between singular and plural, and it is therefore difficult to interpret some of the statements made in this paragraph. At the beginning of the paragraph the writer seems to be discussing the processing applied to a single moving body ("When ***a moving body*** enters the image capture area..."), whereas in the subsequent statements "obtains the features and position for ***each*** moving body region" and "compares the information relating to ***each*** moving body", "each" seems to refer to each of various moving bodies that may be detected at one time. However, despite the presence of more than one moving body being detected, target body tracking means 44 is able to identify one of these moving bodies as the target of interest to be tracked. (In this connection, see paragraph 30, where it is stated that data relating to moving bodies that are not of interest, such as the swaying of tree branches, are deleted).

5. Although the Japanese in this long sentence does not indicate in any way whether "camera angle of view", "image capture area" and "table number" is to be interpreted as singular or plural in number, I have assumed that each of these can be either singular or plural. In this invention both the moving body detection camera and the monitoring camera (the later employed for close-up tracking) are attitude-controllable, and it would seem that the angles of view employed are independently adjustable. However, there may also be times in the course of the tracking process when only one angle of view has to be altered, or indeed when neither angle of view has to be altered.

6. The Japanese which I have translated as "for an example where the image capture area of the moving body detection camera has been divided into 5×5 blocks" is literally "for an example where ***it*** has been divided into 5×5 blocks". My expansion of "it" is aimed at clarifying the writer's presumable meaning.

7. Sic.

8. The Japanese text erroneously has "attitude control means 31 and 32" here. I have made the necessary correction.

9. Sic. Note that everywhere else in the Japanese text, 42 has been identified as the "feature and position extraction means", rather than the "feature vector extraction means".